## REMARKS/ARGUMENTS

## I. INTRODUCTION

Claims 1-9 are pending. Applicants have amended claims 1 and 5.

The Examiner rejected:

a) claims 1 through 9 under 35 U.S.C. § 101 as failing to claim statutory subject matter;

b) claims 1, 3, 4, 5, 6, 7 under 35 U.S.C. § 102(b) as anticipated by Bultan *et al.* (ACM Transaction 1999, Model-checking of Concurrent Systems with Unbounded Integer Variable: Symbolic Representations, Approximation, and Experimental Results);

and claims 1 and 2 as anticipated by Hsieh *et al.* (IEEE 1998, Model abstraction for formal verification);

c) claims 8 and 9 under 35 U.S.C. § 103(a) as anticipated by Bultan *et al.* as applied to claims 1-7, in view of Lincoln et al (USPG-PUB No. 2003/0033126).

Reconsideration of the application in view of the amendments to claims 1 and 5, and the remarks presented herein, is respectfully requested.

## II. CLAIM REJECTIONS

### A. REJECTION OF CLAIMS 1 through 9 under 35 U.S.C. § 101

The Examiner has rejected claims 1-9 under 35 U.S.C. § 101 "because the claimed invention merely directed to an abstract idea. Furthermore, the claims do not produce a useful, concrete, tangible result provided in the claimed invention. *See MPEP 2106 [R2].*" Office Action, paragraph 2.1.

In response, Applicants have amended claim 1 (from which claims 2-4 depend) and claim 5 (from which claims 6-9 depend) in order to more clearly describe aspects of Applicants' invention. Applicant opines that the amended claims recite a practical invention (not merely an "*abstract idea*") and that the claimed invention produces a useful, concrete and tangible result.

I. THE INVENTION AS CLAIMED HAS A PRACTICAL APPLICATION, AND PRODUCES A USEFUL, TANGIBLE, AND CONCRETE RESULT

The USPTO's *Interim Guidelines for Examination of Patent Applications for Patent Subject Matter Eligibility*[1] ("Guidelines") collects and concisely sets forth the rules and requirements of the current law as it relates to examination for compliance with 35 U.S.C. § 101, including, *inter alia*, the cases cited by the Examiner in the present Office Action. The Guidelines describe that "[i]n determining whether the claim is for a 'practical application,' the focus is not on whether the steps taken to achieve a particular result are useful, tangible, and concrete but rather that the final result achieved by the claimed invention is 'useful, tangible, and concrete.'" *Guidelines* at 20. Although the phrase "abstract discrete system" is used in the claims, the invention is not directed to an "abstract idea" but rather to creating a discrete "abstraction" of a "system," of form suitable for formal analysis with respect to a property of interest. The abstract discrete system is stored, thereby producing a useful, tangible, and concrete result. As the inquiry for § 101 focuses on the result of the claimed invention (an abstract discrete system, stored and ready for further formal analysis), and not on the steps taken (those that manipulate formulae), the claims fully satisfy the requirements of 35 U.S.C. § 101.

a. USEFUL RESULT

For the result to be useful, it must have a "(i) specific, (ii) substantial, and (iii) credible" utility. *Id.*; *see also* MPEP § 2107. In the present Application, the result (an abstract discrete system) of the claimed invention is described as being useful because it is "suitable for formal analysis." The field of "formal analysis" is a well-recognized specialty in Computer Science focused on creating tools for problem solving in many areas, including but not limited to hardware specification. The invention is important because the method provides an output, i.e. an abstraction of a discrete system, where such output in turn enables, through formal methods, the characterization of biological and chemical systems (specification paragraphs [20] and [21]), as

1 http://www.uspto.gov/web/offices/pac/dapp/opla/preognotice/guidelines101_20051026.pdf

well as monitoring and diagnosis and model validation in, for example, plant control (Specification paragraphs [35] *et seq.*)

The Examiner has not provided details of the grounds of the rejection other than stating the claimed invention is merely directed to an abstract idea. Applicants' position is that although the claimed methodcreates "abstractions," the method and its result itself is not an abstract idea but a method having very specific, substantial, and credible utility. The Specification provides a variety of examples of the utility of the method. Thus the output of the inventive method is useful, having specific, substantial, and credible utility.

b. TANGIBLE RESULT

Tangible is the opposite of abstract. *Guidelines* at 22. "The tangible requirement does not necessarily mean that a claim must either be tied to a particular machine or apparatus or must operate to change articles or materials to a different state or thing." *Id.* at 21. "However, the tangible requirement does require that the claim must recite more than a § 101 judicial exception, in that the process claim must set forth a practical application of that § 101 judicial exception to produce a real-world result." *Id.*

The result of an output of the method is not an abstract result. Indeed, the claims at issue are tied to a system under investigation: perhaps biological, chemical, genetic, mechanical, or climatic: any hybrid system. The method and output further operate to change the state of the system to a different state. Even if one were to take the position, *arguendo*, that the claims fall within a § 101 judicial exception, a real-world result is realized in the output of the abstract discrete system.

c. CONCRETE RESULT

To be concrete, "the process must have a result that can be substantially repeatable or the process must substantially produce the same result again." *Guidelines* at 22. "The opposite of 'concrete' is unrepeatable or unpredictable." *Id.*

Applicants' claimed result is concrete. The claimed method is repeatable and will produce *precisely* the same result on subsequent invocations of the method when invoked with the same hybrid system and the same property of interest.

For at least the foregoing reasons, the Applicants respectfully submit that claims 1- 9 produce a useful, concrete, and tangible result, and as such fully satisfy the requirements of 35 U.S.C. § 101 and are patentable thereunder.

B. REJECTION OF CLAIMS 1 through 7 under 35 U.S.C. § 102(b)

The Examiner has rejected Claims 1 and 3-7 under 35 U.S.C. § 102(b) as allegedly anticipated Bultan *et al.*., "Model-Checking Concurrent Systems with Unbounded Integer Variables: Symbolic Representations, Approximations, and Experimental Results" ACM Transactions on Programming Languages and Systems, Vol. 21, No. 4, July 1999, pp. 747-780. Examiner also cites a § 102(b) rejection of claim 1 in light of Hsieh *et al.* IEEE 1998, Model Abstraction for Formal Verification, pp. 140-147.

With respect to claim 1, the Examiner characterizes Bultan *et al.* as teaching the functional equivalence of a method for constructing an abstract discrete system suitable for formal analysis as follows:

a) selecting a set of polynomials from the polynomials contained in the property of interest and the hybrid system (pg. 751-753)

b) saturating the selected set of polynomials (pg. 751-753)

c) constructing the abstract discrete system over a set of abstract states defined by the positive, negative and zero valuation of the saturates set of polynomials (pg. 751-753).

However, on pages 751-753, Bultan *et al.* merely summarizes a variety of methods for analyzing infinite-state concurrent programs and discusses them in general, high-level terms. Included within the pages cited by the Examiner are the briefest summaries of the following approaches: Abstraction in Model Checking; Symbolic Execution; Presburger Arithmetic Verification; Abstract Verification; Abstract Interpretation; Model Checking Hybrid Systems; Widening Technique; Combining Model Checking with Theorem Proving; and Symbolic Representation.

Bultan *et al.* summarizes the general art area but does not teach the "functional equivalence" of Applicants' invention. Specifically, referring to independent claim 1, Bultan *et al.* does not teach, nor do any references cited by Bultan *et al.* teach, the "saturation" step described in Applicants' specification at paragraphs [107] through [115]. Nor does Bultan *et al.* teach or cite to a teaching of the "construction" step in Applicants' specification at paragraphs [116] through [168] (see paragraphs per US2004/02207861A). Bultan *et al.* does not teach or discuss saturating a selected set of polynomials by adding to the set the time derivative of each of the polynomials as described in, for example, Applicants' paragraph [108].

For at least the foregoing reasons, Applicants respectfully disagree with the Examiner that the teaching of Bultan *et al.* is a "functional equivalence" of Applicants' claim 1.

Further in regard to claim 1, in paragraph 4.1 the Examiner contends that Hsieh *et al.* teaches the functional equivalence of a method of constructing an abstract discrete system suitable for formal analysis of a hybrid system, with respect to a property of interest, said method comprising the steps of: a) selecting a set of polynomials form the polynomials contained in the property of interest and the hybrid system (pp. 140-143); b) saturating the selected set of polynomials (pg. 140-143); c) constructing the abstract discrete system over a set of abstract states defined by the positive, negative and zero valuation of the saturates set of polynomials (g. 140-143).

Hsieh *et al.* teaches model extraction based on the techniques based on the semantics of the VHDL (p 140, col. 2) obtained by semantic extraction. Specifically, Hsieh *et al.* teaches a model abstraction approach using three techniques: key value extraction, model partitioning through min/max data-flow analysis and data abstraction through relational algebra. (p 140, col. 2). From the Examiner's citation of pages 140-143, it appears the Examiner contends that Hsieh's model extraction (section 4, page 141) and, specifically, section 4.1 Key Value Extraction (p. 142-143) anticipate the steps of claim 1. Applicants respectfully disagree.

Hsieh *et al.* does not teach the "saturation" step described in Applicants' specification at paragraphs [107] through [115]. Nor does Hsieh *et al.* teach the "construction" step in Applicants' specification at paragraphs [116] through [168] (see paragraphs per US2004/02207861A). Hsieh *et al.* does not teach or discuss saturating a selected set of polynomials by adding to the set the time derivative of each of the polynomials as described in, for example, Applicants' paragraph [108].

For at least the foregoing reasons, Applicants respectfully disagree with the Examiner that the teaching of Hsieh *et al.* is a "functional equivalence" of Applicants' claim 1.

The Examiner asserts (Office Action, paragraph 3.2) that Bultan *et al.* teaches that the step of saturating the selected set of polynomials is stopped before normal termination (pg 142-146). Applicants interpret the Examiner's statement as a mis-statement, and as intending to refer to the Hsieh *et al.*, Model Extraction for Formal Verification, IEEE 1998, pp. 140-147. However, even interpreting the statement as referring to Hsieh, *et al.*, the Examiner's characterization is not supported by the text of Hsieh *et al.* Hsieh *et al.* teaches construction of a non-deterministic finite automaton (NFA) such that key value extraction reduces state space by replacing signal variables with symbolic data types of smaller ranges (Hsieh, p 143 col 3). Hsieh *et al.* further states that, for some systems, data abstraction may be necessary to reduce the size of the state space, and emphasizes abstraction based on the relation of key variables. Nowhere does Hsieh *et al.* teach or suggest that saturating the set of polynomials is stopped prior to normal termination.

In paragraph 3.3, the Examiner states:

"As per claim 3, Hsieh *et al.* teaches the hybrid system has no discrete components (pg. 752, 764-768)."

Applicants respectfully interpret this as a reference to Bultan *et al.* (rather than Hsieh *et al.*) based on the page citations and responds accordingly. On page 752, Bultan *et al.* states: "A hybrid system is a discrete control automaton, that interacts with continuously changing external parameters." On pages 764-768, Bultan *et al.* teaches a Symbolic Model Checker, wherein Bultan uses Presburger formulas for symbolic representations, and by means of the Omega Library computes the truth set for the temporal properties.

Applicants cannot agree with Examiner's characterization of Bultan *et al.* as teaching the elements of Applicants' claim 1, and therefore cannot agree that the dependent claims are anticipated.

In paragraph 3.4 the Examiner states, "As per claim 4, Bultan *et al.* teaches that eigenvectors are used to generate polynomials (pg. 762-768). Applicants note that "eigen" does

not appear anywhere in the Examiner's cited reference. Applicants disagree with the Examiner for the reasons stated above and further in light of the amendment to Claim 1 herein.

In paragraph 3.5, the Examiner states: "With regards to claim 5, Bultan *et al.* teaches the functional equivalence of a method for determining the validity of a property of interest with respect to a hybrid system, said method comprising the steps of: a) abstracting the hybrid system to create an abstract discrete system (pg. 751-753)." Applicants disagree for the reasons stated above, and further in light of Applicants amendment of Claim 5 herein.

In paragraph 3.6, the Examiner states: "Regarding claim 6, Bultan *et al.* teaches that the property of interest is invalid with respect to the abstract discrete system, creating a finer abstraction of the hybrid system and analyzing the property of interest with respect to the finer abstraction (pg. 751, 760-773)". Applicants disagree for the reasons set forth above, and further in light of Applicants' amendments to the Claims herein.

In paragraph 3.7, the Examiner states: "As per claim 7, Bultan *et al.* teaches that analyzing the validity of the property of interest is performed by model checking (see title, pg 752)." Applicants disagree for the reasons set forth hereinabove and further in light of the amendments to the Claims herein.

C. REJECTION OF CLAIMS 8 and 9 under 35 U.S.C. § 103(a)

Examiner has rejected claims 8 and 9 under 35 U.S.C. §103(a) as unpatentable over Bultan, *et al.*, as applied to claims 1-7, in view of in USPG Pub No. 2003/0033126. [Office Action, paragraph 5]. The Examiner cites paragraph [90] of the US published application no. 09/855,458 (published February 13, 2003) as teaching the "advantage of decision diagram for efficiency manipulation and representation and the improvement of efficiency (sic)" Office Action, paragraph 5.1. The Examiner opines that because Bultan *et al.* addresses hybrid systems, the mention of decision diagrams with regard to biological systems in Lincoln *et al.* renders the HybridAbstraction invention taught in the instant application obvious to one of average skill in the art.

Applicants have already shown that Bultan *et al.* does not teach the invention of independent claims 1 and 5 as discussed hereinabove, nor any of the claims dependent therefrom. Lincoln *et al.* fails to bridge this gap in the teachings of Butan *et al.* Therefore, Applicants

respectfully submit in light of the Claim amendments herein, and for at least the reasons set forth above, Examiner's grounds for rejection are overcome, and claims 8 and 9 are in condition for allowance.

**CONCLUSIONS**

In view of the foregoing, it is respectively urged that all of the present claims of the application are patentable and in a condition for allowance. Notice of allowance is earnestly solicited. The undersigned attorney can be reached at 650-323-2969 to facilitate prosecution of this application, if necessary.

Respectfully submitted,

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